EXHIBIT 13

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Player Salary Share and the Distribution of Player Earnings

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Veteran free agency in professional team sports has led to higher average player compensation, an increase in the share of league revenues going to players, and increased dispersion in player earnings. Tests on the distributions of player salaries in the last decade reject that they are the same in the early and later years. The variance in baseball player compensation is decomposed into share and marginal revenue product effects for 1990 and 1998, and it is found that both effects contributed to the increased variance in player salaries. A simulation of the effect of universal free agency in baseball suggests a modest increase in player salary share and a drop in compensation inequality among players. Copyright © 2004 John Wiley & Sons, Ltd.

INTRODUCTION

While all professional team sports had monopsonistic labor markets in the past, all have veteran free agency, now. This change from a restricted to a free labor market (at least for eligible veteran players) creates a natural experiment in which the effects of freedom of the market can be examined and measured. These effects are predictable: an increase in player pay, salary as a higher share of revenue, and a greater dispersion in player earnings. Average player compensation, in 2000, in the NBA is 140 times its level in the 1967–1968 season and 105 times its 1967 level in baseball. While the increases in player compensation are not quite so dramatic in football and hockey, they are very substantial. Compound growth rates of player pay in basketball of 16.5% per annum and in baseball of 15% have outstripped the growth rates of revenues in these sports by several percentage points. As such, player compensation as a share of revenue has more than doubled, since the late 1960s. While superstar players in the past earned 10–15 times rookie pay, now some earn 50–75 times minimum salary. The relative rise in the compensation of veteran free agents compared to other players has lead to about a doubling of earnings inequality (measured by the Gini coefficient) in basketball and hockey, and a very substantial rise in inequality in baseball and football.

In this paper, the effect of veteran free agency on player compensation share and on the distribution of player compensation is examined. In Section 2 of the paper, player compensation share is examined in 1970–1973, 1980, and annually from 1990. One sees sharp breaks in the compensation share in sports where the shift to veteran free agency is at a time certain. But, each sport has a different history and experience in securing this benefit for veteran players, and these differences are briefly discussed. Since regular roster (including injured reserve) player compensation as a share of revenue is in the 50–55% range in all sports, now, one naturally asks if this is the upper bound share (Section 2.1)? The change in the distribution of player earnings between 1990 and 1998 is examined for all of the sports in Section 3. Nonparametric tests for the equality of two distributions and parametric tests for the

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interperiod differences in the Gini coefficients are performed. In Section 4, baseball player compensation and marginal revenue product are compared. Section 4.1 discusses the methodology of estimating gross marginal product in baseball, and presents the results. In Section 4.2, the variance in player salary, salary share, and marginal revenue product is computed for the 1990 and 1998 baseball seasons to determine the order of magnitude between share effects and marginal revenue product effects on the variance in salary. Conclusions follow in Section 5.

COMPENSATION SHARE IN PROFESSIONAL TEAM SPORTS

Prior to veteran free agency, players were restricted in their ability to move between clubs. Leagues imposed a reservation clause (baseball) or an option clause in player contracts. Where an option clause was in effect, in theory, players were free to seek offers from other clubs, after playing out their options, but compensation or transfer fees were so high (e.g., football, with two first-round draft choices) that player-initiated transfer was precluded. The result of these restrictions was that player salary or compensation as a share of league revenues was rather small. As is seen in Table 1, in 1970–1973, players got somewhat less than 16% of revenues in baseball, and about 21% in ice hockey. Major league baseball and the National Hockey League had the most restrictive labor market rules. In football and basketball, player salary share was higher in this period. Players benefited, at various times, from inter-league competition in football (AFL 1960–1969, WFL 1974–1975, USFL 1983–1985), basketball (ABA 1968/60–1975/76), and in hockey (WHA 1972/73–1978/79). This competition put considerable upward pressure on player salaries. While the labor market was restricted *de jure*, the prospect of players jumping to the competing leagues forced salaries and the player share of revenues upward.

Table 1. Player Compensation as a Share of Revenue in Profession Team Sports

Year	MLB	NBA	NFL	NHL
1970/73	15.9	46.1	34.4	21.3
1980	31.3	NA	35.4	NA
1990	31.6	40.6	41.0	30.0
1991	45.3	39.3	47.2	32.6
1992	57.8	43.8	59.6	39.1
1993	56.5	49.5	69.8	40.7
1994	63.4[a]	41.4	64.1	41.4
1995	61.9[a]	46.2	65.3	38.2[a]
1996	53.6	46.9	60.1	51.1
1997	50.6	NA	53.4	NA
1998	48.4	54.2	55.4	58.4

[a] Shortened season due to player-management contract dispute.
Sources: For 1990–1996, except for player salary in football, figure is player compensation divided by total revenue from *Financial World*. For football (1992–1998), total player pay was provided by the NFLPA. For 1997 and 1998, data is from *Forbes*. Earlier data is from Scully (1989, p. 112), and from various Congressional Hearings in 1976 and 1982.

Veterans got free agency in baseball through arbitration in 1975, with the first free agents entering the market in 1976. In basketball, players gradually got relaxation of the labor market rules in various court decisions, and, ultimately, extracted veteran free agency as the price of the NBA-ABA merger.[1] In 1976, players got liberalization on drafting rights, elimination of the option clause for nonrookie players, and a system of 'Right of First Refusal.' By 1988, all restrictions were eliminated for free agents. The players operate under a so-called soft salary cap (from the 1984/85 season, until recently, 53% of league gate and television revenues). Because of the Larry Bird exemption (retaining a veteran, no matter the cost, does not count in the cap), all of the clubs are above the cap. After more than two decades of very contentious management–player union relations, football got veteran free agency through collective bargaining, in 1993. The NFL has a hard salary cap (initially, a maximum 67% of designated revenues), but some clubs have gone above the cap. After many years of operating under 'equalization' compensation (draft choices in the later years), veteran free agency came last to hockey, in 1995.

Examination of the player earnings share in Table 1 reveal some interesting shifts, due to the increase in freedom in the labor market. In football, player salary share is in the 35–40% range to 1990, and was about comparable to the share in the NBA. One must not read differences in the effect of freedom of the players' labor market here. Rather, a football team has about 4 times as many players as a basketball team, and by roster size alone football will tend to have a higher player share of revenues. Beginning in 1991, and continuing in 1992, player salary share rose.

Likely, these jumps are due to the effect of the raft of player-initiated antitrust suits against the NFL, and the trend in findings for the players. The peak in the NFL player salary share is in 1993, and it remained high in 1995 and 1996. But, player salary as a share of total NFL league revenues has declined since then. The owners are required to allocate 67% of designated revenues (gate receipts, media income, and some other revenues) for player salaries. In 1993, designated revenues were about 95% of total revenues. But, owners have been inventive in growing nondesignated revenues. The rising fraction of nondesignated revenues out of total revenues (roughly 15%, today) has meant a decline in player compensation out of total NFL revenues.

In hockey, player salary share rose between 1990 and 1994, as the restrictive labor market rules gradually relaxed. In the 1994/95 season, an owners' lock-out shortened the season to 48 games. Player salary share in hockey jumped sharply in 1996 and 1998 as competition for veteran free agents accelerated.

In the NBA, there is no sharp break in player salary share. The labor market in basketball has been relatively free for a long time, and over the years has extended free agency to a larger class of players. No data is available for 1997, but the player share broke the 50% mark, in 1998. The 1999 observation should be treated with caution, since an owners' lock-out shortened the season.

The history of player salary share in baseball is different from the other sports. Basically, there have been no major changes in the labor market rules in baseball, since 1976. Veterans are free agents with 6 years of experience. One would anticipate that there would be a sharp rise in the player salary share occurring with veteran free agency, followed by a long period of relatively flat player salary share. But, this is not the case. In 1977, player compensation was 24.8% of total revenue, compared to 17.1% in 1973. In 1980, the share had risen to 30.8%. In 1982 (1984), the relative share was 43.2 (39.8)%. In 1988, player salary share had fallen to 32.8%, and was even lower in 1990. This decline in player salary share is linked to owner collusion against veteran free agents. Marvin Miller, director of the baseball players' association, had raised the issue of owner collusion in the market for veteran players in testimony before Congress, in 1982 (Oversight Hearings, 1984, pp. 477–478). Grievances were filed on behalf of players throughout 1982–1987, and eventually the owners' were found to have colluded, and paid compensation.

With collusion in the market for veteran free agents eliminated, player compensation shares rose to 48% or so in 1992 and 1993. In 1994, there was a strike-shortened season; in 1995, there was an owners' lock-out-shortened season. The player salary share figures for these 2 years are not representative. Fans were drawn back to baseball, with the 1996 season, which produced a record number of home runs (nearly, 5000).[2] Recovery from the strike-lock-out seasons took place in 1998, when Mark McGwire with 70 home runs and Sammy Sosa with 66 brought more fans to the ballparks. Player salary shares in 1996 and 1997 are above 50%, but declined to 48.4% in 1998.

Absent the period of owner collusion and its aftermath (roughly, the period 1982–1990), it is probable that player share in baseball would have been comparable to that in the NBA, or about 45% or so, by the early 1980s.

While it may be too early to tell, it appears on the basis of the data for 1996–1998, and with the existing labor market and contract terms that govern draft choices, rookies, journeymen players, and free agency-eligible veterans contained in the various collective bargaining agreements, that player compensation as a share of total revenue is converging among the team sports at about 50–55%.

Maximum Compensation Shares in Professional Team Sport

Is 50% or so as the player share the upper bound in professional team sport? One suspects that it is not, for several reasons. First, while veteran free agents on average may be paid their net marginal revenue products, journeymen players, who receive some minimum salary geared to their years in the league (e.g., football, basketball) or are eligible for arbitration (baseball), and rookie players, who usually receive the rookie minimum salary, may be paid less than their net marginal revenue product.[3] Most of the players' associations, from time to time, push for liberalizing the rules on free agency. If all players were free agents, salary as a share of revenues would rise substantially. The leagues have strongly resisted further liberalization in the players' labor market rules.

Second, while net operating income as a fraction of franchise value on average is not particularly high in professional team sports, and the number of franchises has more than doubled, franchise values continue to rise at 10–15% or so per year (Scully, 1995, p. 132; Quirk and Fort, 1992, p. 49–63)[4]. In baseball, the median appreciation rate of 16 franchise sales between 1991 and 1998 was 9.8%, with a range between 5.4% (Detroit) and 19.8% (Baltimore). Estimation of profitability is another matter. Getting at actual net operating income, even with audited financial data, is tricky (Noll, 1985; Scully, 1989, pp. 129–143). But, it is clear that all of the monopoly profit available in these sports has not been transferred to the players. If one takes the American economy as a whole, labor compensation is about 75% of national output. One would expect that under unrestricted free agency for all players the upper bound on player compensation as a share of revenue in team sport would approach about 70%.

Third, under whatever set of labor market rules that govern management–player contracts, and assuming that other costs of producing games are minimized and stable over time, in equilibrium the growth rate in player salaries will equal the growth rate in club revenues. Average player salary (average club salary, since roster size is constant), S, is player share of club revenues, s, times revenue, R. Thus, $S=sR$. Then, $\mathrm{d}S=R\,\mathrm{d}s+s\,\mathrm{d}R$, and $\mathrm{d}S/S=g_s=(R/S)\,\mathrm{d}s+s(\mathrm{d}R/S)=s^{-1}\,\mathrm{d}s+(S/R)(\mathrm{d}R/S)=s^{-1}\,\mathrm{d}s+\mathrm{d}R/R=s^{-1}\,\mathrm{d}s+g_R$. In equilibrium, the change in player salary share, $\mathrm{d}s$, is zero, and the growth rate in average player salary is equal to the growth rate in club revenue.

Table 2 presents calculations of the nominal growth rates of average club revenue and player compensation for the period 1970–1990 and for 1990–1998. In the earlier period of the NBA, revenue and compensation growth rates are comparable. In the later period, the growth rate in player salary exceeds that of the growth rate in revenue by about 4 percentage points, and this is consistent with the upward trend in NBA player salary share. In the NHL for the monopsony period, the growth rate of player salary is 2.2 percentage points more than the growth rate of revenues, but with veteran free agency, player compensation grows at 9.5 percentage points higher than revenue. A similar story exists for the NFL. Player compensation and club revenue grow at comparable rates over the period 1970–1990 (monopsony period). With veteran free agency, the growth rate in player compensation is 5.3 percentage points higher than revenue growth in 1990–1998. In baseball, veteran free agency accelerated salary growth above revenue growth by 4.2 percentage points in the 1970–1990 period, which includes the period of owner collusion against free agents during the 1980s. With collusion stopped, the 1990–1998 period reflects acceleration of player salary growth compared to revenue growth (12.8 compared to 7.0%).

Table 2. Growth Rates of Revenue and Player Compensation 1970–1990 and 1990–1998

Period	g_R	g_s
MLB		
1970–1990	11.7	15.9
1990–1998	7.0	12.8
NBA		
1971–1990	8.5	7.8
1990–1998	14.1	18.3
NFL		
1970–1990	12.0	12.2
1990–1998	11.1	16.4
NHL		
1973–1990	10.0	12.2
1990–1998	12.0	21.5

CHANGES IN THE DISTRIBUTION OF EARNINGS AND FREEDOM OF PLAYER MOVEMENT

Average player salaries and player share of revenue have risen dramatically in all professional team sports, since the market for player services has been liberalized. If the effect of labor market liberalization was uniform across all levels of playing talent and characteristics (e.g., draft choices, rookies, journeymen, veterans, starting and backup players), one would expect an increase in the mean salary, but no statistically meaningful differences in the other moments of the distribution of player compensation. On the other hand, if liberalization affected certain classes of players (i.e., veteran free agents) more than other types, as is likely, then the entire distribution may have been altered by the regime change.

To examine this issue, the distributions of player compensation for the four team sports are compared between years when the players' market was less liberal with years when it was more liberal. These comparisons are as follows: (i) for major league baseball, 1990 with 1998; (ii) for the NBA, 1988/89 with 1999/2000; (iii) for the NFL, 1990 with 1998; and (iv), for the NHL, 1990/91 with 1998/99.

The summary statistics for the distributions of player compensation appear in Table 3. In all of the sports, the mean player compensation has risen dramatically, and the variance is much greater under liberalization. Average player salary at \$2.8 million is highest in the NBA, with MLB following at nearly \$1.4 (\$2) million in 1998 (2000).[5] This differential in average pay between the NBA and the other professional team sports has been an historical fact, and in part is due to the greater liberalization in player-initiated transfer in the NBA compared to the other sports.

The greater dispersion in player compensation observed in all of the sports can be verified by comparing the variance or the coefficient of variation in the recent period with that in the earlier period. As one would suspect, the distributions of player compensation are asymmetrical. The skewness and kurtosis coefficients are positive, which indicates that the distributions are right skewed and the density is more peaked than for the normal curve. On the basis of the Gini coefficients, inequality of player compensation has risen sharply in all of the sports. The rise in earnings inequality is even greater when compared to earlier years. In baseball, the Gini coefficient was 0.372 in 1973, in basketball was 0.274 in 1967/68, and in hockey was 0.224 in 1977/78 (Scully, 1995, p. 74). Earnings inequality remains highest in baseball at 0.626 and lowest in hockey at 0.458.

The entire set of moments of a distribution ordinarily determine the distribution exactly. On the basis of the four moments of the distributions

Table 3. Statistics of Distributions of Player Compensation

Measure	MLB			NBA		
	1990		1998	1989		2000
Mean	647.5		1379.7	528.9		2826.9
Variance*10^{-3}	349.8		3555.0	223.4		9685.2
Skewness	1.23		2.16	2.42		2.00
σ/Mean	0.91		1.37	0.89		1.10
Kurtosis	0.94		5.68	8.50		4.17
Median	447.5		410.0	380.0		1886.7
Gini	0.482		0.626	0.428		0.528
σ_{Gini}	0.017		0.013	0.028		0.021
Runs		z = 468			z = 144	
Statistic		−15.31			−17.44	
Rank sum		T_x = 747 847			T_x = 236 068	
Statistic		5.98			17.31	
N	666		892	320		464
	NFL			**NHL**		
	1990		1998	1991		1999
Mean	366.4		783.1	232.3		1041.3
Variance*10^{-3}	126.6		759.3	44.7		1339.0
Skewness	4.73		2.46	6.84		3.90
σ/Mean	0.97		1.11	0.91		1.11
Kurtosis	36.94		8.80	70.44		25.20
Median	275.0		400.0	185.0		650.0
Gini	0.397		0.512	0.319		0.458
σ_{Gini}	0.014		0.011	0.025		0.018
Runs		z = 406			z = 168	
Statistic		−38.70			−28.49	
Rank sum		T_x = 2 682 674			T_x = 859 829	
Statistic		15.78			28.48	
N	1445		1795	539		896

reported in Table 3, it can be concluded that there is an interperiod difference in the distributions of player compensation in all of the sports.

Nonparametric Tests

There are a number of nonparametric tests for the equality of two distributions (Mood *et al.* 1974, 518–524). Two nonparametric tests were selected and performed: the run test and the Wilcoxon/Mann–Whitney rank sum test. The run test is good against various sorts of departures, and does not assume independence of the two sets of data. If the distributions are similar (widely separated), the total number of runs will be large (small) compared to the number of observations. The Wilcoxon/Mann–Whitney or the rank-sum test will yield relatively small (large) values of the difference between the sum of the ranks and the expected sum for similar (widely separated) distributions.

The results of these two nonparametric tests are reported in Table 3. Runs as a percent of the combined samples range from 11.7% in the NHL to 30.0% in MLB. On this basis (i.e., a rather small number of runs) and the test statistic, one rejects that the distributions are similar in a statistical sense. A similar conclusion results from the Wilcoxon/Mann–Whitney rank sum test. All of the rank sums are large, and this along with the test statistic leads to the rejection of the hypothesis that the distributions are equal.

A Parametric Test

Formerly, calculation of the standard error of the Gini coefficient was hampered by mathematical complexity and the laboriousness of numerical calculation, using the jackknife technique (Sandstrom *et al.* 1988). Recently, Giles (2002) has swept away all of this complexity and computational intensity by showing that the standard error of the Gini coefficient can be obtained by OLS (WLS) regression techniques.

If the observed data, y, are in increasing order, then Ogwang (2000, p. 124) shows, for the case of normally distributed (homoskedastic) errors, that the Gini can be defined as

$$\text{Gini} = [(n^2 - 1)/(6n)](\beta^*/\bar{y}),$$

where $\bar{y}$ is the sample mean and β^* is the OLS estimator in

$$y_i = \alpha + \beta i + \varepsilon_i.$$

Alternatively, since the errors are likely to be heteroskedastic, the Gini can be defined as

$$\text{Gini} = (2\theta^*/n) - 1 - (1/n),$$

where θ^* is the WLS estimator of θ.

The standard error of the Gini is

$$\sigma_{\text{Gini}} = 2[\sigma(\theta^*)]/n,$$

with $\sigma(\theta^*)$ coming from the WLS estimation.

Using this simplification, the standard error of the Gini coefficient was obtained for each of the sports. The σ_{Gini} for each of the Gini coefficients appears in Table 3. A 95% confidence interval can be constructed by multiplying σ_{Gini} by ± 1.96. Inspection of these confidence intervals reveals that the lower bound of the Gini in each of the sports for the later or freer labor market period is usually well above the upper bound of those for the earlier or more restricted period. Thus, these Gini coefficients are statitically different from those of the earlier period.[6]

COMPENSATION AND MARGINAL REVENUE PRODUCT IN MAJOR LEAGUE BASEBALL

The large increase in the variance of player compensation and the shift in the earnings distribution toward more inequality have been established. At issue is to what degree these changes are due to greater variance in player share of marginal revenue product or due to greater variance in marginal revenue product among the players. To answer this question the marginal revenue product of the players must be calculated. This is most facilely done for baseball players. The comparison of the variances will be between those ball players on the 1990 and 1998 major league rosters.

Estimating Marginal Revenue Product

The first estimates of player marginal product in sports were those for major league baseball (Scully, 1974). Using a simple two equation model, with data for the 1968 and 1969 seasons, relationships between win percent and player performance, and between revenue and win percent were estimated. The first equation related the club win percent to a measure of team hitting (the slugging average), team pitching (the strike-to-walk

ratio), and some other variables. The second equation related team revenue to club win percent, population, and some other variables. A considerable literature arose that sought to refine the estimates of player marginal revenue product in baseball (see Fort (1991) for a partial bibliography), and then sought to apply this general model to other team sports. Much of the refinement in the estimates of player marginal revenue product arose from considering other or more explanatory variables, refining the difference between gross and net marginal revenue product, obtaining a larger number of players in the sample, and altering the functional form of the equations.

For the purpose of this paper, a two equation model is utilized. The first equation, estimated by OLS, relates the team win percent to the team slugging average and to the inverse of the team earned run average (1/ERA). These two variables capture most of the variation in player and pitcher quality.[7] The second equation relates club total revenues less media revenues to the win percent, the win percent lagged one season, population, and for the 1998 season, dummy variables for recent expansion teams (Colorado, Arizona, Tampa Bay, Florida) and new ballparks (Cleveland, Atlanta, Baltimore, Texas, Chicago White Sox), since such characteristics raise revenue independent of the club record or market size. I have chosen to subtract media revenues from total revenues because media revenues have little or nothing to do with the club record, and they vary tremendously across teams. Since the win percent in the second equation is endogenous, the revenue equation is estimated by 2SLS.

Standard tests for heteroskedasticity were performed. On the basis of the χ^2 values, the residuals of the production function equations (WIN90, WIN98) are normal, while those of the revenue function equations (REV90, REV98) are heteroskedastic. Accordingly, the standard errors of the 2SLS equations are corrected for heteroskedasticity, using White's (1980) heteroskedastic consistent covariance matrix estimation.

The empirical results appear in Table 4. On the whole, the parameter estimates are statistically meaningful, and a good part of the variance is associated with the explanatory variables. For 1990 (1998), a one point change (i.e., 0.001) in the team slugging average raises the win percentage 1.354 (1.6437) points (e.g., 0.001354). A one point increase in ERA^{-1} raises the win percent 1.78

Table 4. Win Percent and Revenue Equations for MLB in 1990 and 1998

Variable	WIN90 OLS	REV90 2SLS	WIN98 OLS	REV98 2SLS
Constant	−0.4873 (3.44)	−43.463 (3.50)	−0.6133 (5.55)	−54.771 (1.92)
TSA_t	1.3540 (4.10)		1.6437 (7.04)	
ERA_t^{-1}	1.7806 (7.58)		1.8427 (7.64)	
WIN_t		60.958 (2.91)		200.16 (3.60)
WIN_{t-1}		65.717 (3.77)		11.523 (0.20)
POP_t		0.00157 (3.73)		0.0020 (1.31)
STAD				29.210 (2.34)
EXPAN				48.991 (7.74)
R^2 Adj.	0.7421	0.4133	0.7931	0.5800
$R^2_{(y,\hat{y})}$		0.4837		0.6523
N	26	26	30	30

t-values in parentheses in OLS equations, asymptotic t-values in 2SLS equations.

(1.84) points. These values are much higher than the ones obtained for 1968–1969 (0.92 for team slugging average and 0.90 for team strike-to-walk ratio). Mainly, the difference is due to the fact that extra-base hitting is more prominent in recent than in past times. For example, the team slugging average is in the range of 0.373–0.468 in 1998 compared to 0.311–0.414 in 1968–1969. Increased hitting has increased the earned run average (3.25–5.22 in 1998 compared to 2.66–4.33 in 1968–1969). There has been no corresponding increase in the spread in team win percentages.

The marginal revenue of a 0.001 point change in the win percent is \$60 958 in 1990 and \$200 160 in 1998. In nominal terms, marginal revenue in 1990 (1998) is about 6 (19) times its level in 1968–1969. These increases in marginal revenue parallel those of club revenue. A typical baseball club had about \$5 million in revenues in 1969, somewhat over \$50 million in 1990, and close to \$90 million in 1998.

Marginal revenue product is marginal revenue times the coefficient of performance on the win percent. For players (pitchers) in 1990 it is 1.354*\$60 958 (1.781*\$60 958) = \$82 537 (\$108 542). For players and pitchers in 1998 the corresponding marginal revenue products are \$329 000 and \$368 800.

Team performance is the linear sum of individual player performance, weighted by player share

of performance. Thus, the *i*th player has slugging average SA_i and has AB_i/AB percent of club at bats. Multiplication of SA_i by the percentage of at bats yields the *i*th player's contribution to team hitting.[8] Summing over *i* players yields the team SA. Multiplication of SA_i^* (AB_i/AB) by MRP (e.g., \$82 537) yields the *i*th player's contribution to club revenues. The *i*th pitcher has pitching performance of $1/ERA_i$ and IP_i/IP percent of the innings pitched. Summing the product of these two variables over *i* pitchers yields the team ERA^{-1}. The product of these two variables times MRP (e.g., \$108 542) yields the *i*th pitcher's contribution to club revenue.

It is important to bear in mind that these estimates of marginal revenue product are gross, not net. Neither all dimensions of player performance have been taken into account nor have nonplayer inputs (e.g., manager, coaches, scouting, travel, stadium) been considered in the production function. And, resources other than those associated with producing wins have not been taken into account, and these resources may directly affect revenues (e.g., advertising, promotions).

Variances in Salary, Salary Share, and Marginal Revenue Product

By definition player salary is salary share times player marginal revenue product. Thus, $S_i = (S_i/MRP_i)^*MRP_i = s_i^*MRP_i$. Taking logarithms on both sides of the expression, and dropping the *i* subscript, we have $\ln S = \ln s + \ln MRP$. As is well known, the variance of two additive variables is $Var\ (\ln s + \ln MRP) = Var(\ln s) + Var(\ln MRP) + 2\ Cov(\ln s, \ln MRP)$.

The result for the 1990 sample ($N = 654$) is $0.9877 = 1.1625 + 0.7537 + 2(-0.4643)$. The result for the 1998 sample ($N = 846$) is $1.5533 = 1.4219 + 1.0555 + 2(-0.4621)$.[9] Both the variance of the logarithm of salary share and that of the logarithm of marginal revenue product have risen substantially in the interim. The source of the increased variance in the player marginal revenue product is the marginal product of hitting and pitching. The ratio of the pitchers' marginal revenue relative to the hitters' marginal revenue actually is lower in 1998 (\$368.8/\$329) than in 1990 (\$108.54/\$82.54). Therefore, the increased variances in player and pitcher marginal product are responsible for the increased variance in the logarithm of marginal revenue product. It is likely that this increased spread in the variance of player performance has made the high levels of performance that are characteristic of veteran free agents more valuable to the clubs, and, as such, has increased their salary share of marginal revenue product relative to nonveteran players.

CONCLUSIONS

With freedom of veteran player-initiated movement, average pay, compensation as a share of league revenue, and the dispersion of compensation among players have increased. The order of magnitude of these effects is substantial. These effects have taken some time to work themselves out. In the NBA, there is no trend in the player share, although the new collective bargaining agreement which sets the salary cap at 55% of designated revenues and which fixes minimum salary for players by years of experience have put some upward pressure on the player share. Nevertheless, within the existing labor market rules, a player share of 60% of league total revenues is unlikely. In the NFL, player compensation share has fallen from its peak level in 1993. This shrinkage may continue to a degree as owners raise revenue from sources not covered by the collective bargaining contract. It is natural for owners to fritter away incremental revenue with inventive ways around the salary cap, but since gate and broadcast revenues are quite equally divided among clubs in the NFL, the financial returns to winning are relatively modest. In the NHL, salary share has risen considerably, but it is too soon to tell whether the 58% share is sustainable. In MLB, player share in the late 1990s is actually less than it was in 1992–1993.

Player-management disputes were more frequent and disruptive in the 1990s than in the past, and this is due to the fact that player average pay was growing at a faster rate than club revenues. Such disputes likely will continue, as owners seek rules through collective bargaining that will help to constrain their financial competition for the limited pool of high quality, veteran free agents. Naturally, the player unions will resist these attempts.

The main beneficiaries of labor market liberalization have been the veteran players. While the

player associations negotiate rookie minimum salary and seek to liberalize the labor market rules for draft choices and journeymen players, these changes have not brought benefits to them nearly as great as those to veteran free agents. An effect of this difference in the labor market rule for veteran and nonveteran players is growing inequality of player compensation. Many nonveteran players are paid less than their net marginal revenue product. The inequality of player compensation would be mitigated to a degree, if all players were free agents. However, club owners would not agree to such a sweeping liberalization in the players' labor market.

To get a feel for the effect of universal free agency, I assumed that all baseball players earning $500 000 or less in 1998 were exploited. Such players are nearly half of the 892 ball players in the sample. I calculated each group's salary as a share of gross marginal revenue product. For players earning more than $500 000, their share of gross marginal revenue product equaled 41.5%. The multiple of salary that caused the share of MRP to be the same for the exploited players as for the nonexploited players was found (a factor of 2.7 times the observed salary). The simulated salary distribution yielded the following results. Average player compensation in 1998 would have been 15% higher than that observed, and player compensation as a share of league revenues would have been 55.7% rather than the observed 48.4%. The Gini coefficient was re-calculated. It dropped from 0.626 to 0.499, or about the level observed in the 1990 sample. While these simulated changes of universal free agency are significant, they are not so dramatic as to threaten the financial integrity of baseball.

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NOTES

1. In hockey, the union, by default or ineptitude, failed to make any gains in liberalizing the rules for player-initiated transfer either in court or as a price to be paid for the shotgun merger of the NHL with what remained of the WHA.
2. Home runs per team were 23.1% higher than in the 1994 season. They were 28% higher by the 1999 season. Partly, the home-run orgy is traced to the greater weight and strength of players. As in other sports, these men are simply bigger and stronger than they were even a decade ago. Barry Bonds, the current home run record holder, saw his home run production about double as his weight went from 190 to 235 pounds . This bulking-up by Bonds paid off in 2001, when he broke McGwire's home run record. Use of steroids is widespread in baseball, and in fact, is not barred by the collective bargaining contract. Also, the baseball is no longer stiched in Haiti. Some suspect that the ball has been 'juiced-up.'
3. League rookie minimum salaries are as follows: NBA, $301 875 (1999–2000), MLB, $200 000 (2000), NHL, $150 000 (1999), and NFL, $144 000 (1998). In the NBA, minimum salaries also are geared to years of experience, ranging from one year ($385 000) to 10 or more years ($1 million).
4. There is not much convincing evidence that appreciation rates of sports franchises have changed much over time. Some decades experience more robust franchise value growth rates than others, but there is no trend. Yet, changes have occurred that ought to effect the long-term equilibrium rate of return. On the positive side, there has been the tremendous increase in broadcast revenues in the post-war period, particularly since the 1960s. On the negative side, there is veteran free agency, curtailment of the allowance of the fraction of the franchise purchase price that can be allocated to depreciable player contracts, and the fall in the top marginal tax rate. On the whole, franchises appear to appreciate at about the rate of equities in the stock market, and given the low failure rates (bankruptcies) of franchises, owning a club is not a particularly risky business.
5. Player salaries continue to escalate. For example, for the 2002 season, the average in baseball is about $2.4 million (NBA ($4.2 million); NHL ($1.43 million); NFL ($1.1 million)). Interclub salary differentials are wide (e.g., in baseball, from $34 million in Tampa to $126 million for the Yankees.
6. It is likely that there would be a gain in asymptotic efficiency (smaller standard errors), if seemingly unrelated regression (SUR) was employed.
7. Other variables were examined. For hitters I constructed a total base percentage [(singles + doubles + triples + home runs + walks + stolen bases)/ at bats]. For pitchers I added a games saved percentage variable. While these variables worked well, they did not add much to the associated variance of the production function. The gain in constructing these variables for the entire sample of ball players in 1990 and 1998 is not worth the effort.
8. For both hitters and pitchers, where performance was with more than one club, the total season performance was calculated.
9. The shrinkage in the sample sizes is due to players with zero MRPs. Mainly, this is due to the fact that they were injured for the entire season or returned to the minors without appearing in a major league game.

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